Heuristic Standards for Universal Design in the Face of Technological Diversity

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CENTRAL PRINCIPLE

Important technologies require validated standards for the design heuristics that are used to design and evaluate them, but not necessarily identical heuristics for every technology.

BACKGROUND

Heuristic standards provide a valuable toolkit with which to evaluate the accessibility of modern information society technologies (IST). But can we apply the same heuristic, generic standards to all types of technological platforms, in the face of their growing diversity e.g. websites, social websites, blogs, virtual reality applications, ambient intelligence etc (Adams, 2007)? Or would it be wiser to expect that different technologies might require different, if overlapping, standards? Can we really expect to design the interface of a modern cell phone on the same basis as for a table computer? Most impartial observers would probably say "no".

How can we introduce a systematic and thorough approach to the diverse technologies that are seen or predicted to be seen? Work in our laboratory has explored two useful questions. First, how to computer literate users perceive the different technologies? Second, how can different heuristic standards be developed where needed?

EXAMPLES

(1) Nielsen's heuristics:

Nielsen, J. & Mack, R. L. (1994). Usability Inspection Methods. Wiley & Sons, New York, NY.

1.	Visibility of system status
2.	Match between system and the real world
3.	User control and freedom
4.	Consistency and standards
5.	Error prevention
6.	Recognition rather than recall
7.	Flexibility and efficiency of use
8.	Aesthetic and minimalist design
9.	Help users recognize, diagnose and recover from errors
10.	Help and documentation

(2) Shneiderman, B. (1998). Designing the user interface: strategies for effective human-interaction. (3rd edition). Reading, MA: Addison-Welsey.
(3) Riel, A. J. (1996). Object-oriented design heuristics. Reading, MA: Addison-Welsey. etc

CURRENT PRACTICE

In case you think that the use of heuristics have matured beyond the picture painted here. Here are two very recent examples, both taken from ITI 2009 (June).

Shehu, V., Besimi, A., Abazi, L. and Shaqiri, M. (2009). Usability Issues Whilst Building a New LMS. Proceedings of the ITI 2009, 31st In. Conf. on Information Technology interfaces, June 22 – 25, Cavtat, Croatia: **used Nielsen's heuristics.**

Silvennoinen, M and Kuparinen, L. (2009). Usability challenges in Surgical Simulator Training. Proceedings of the ITI 2009, 31st In. Conf. on Information Technology interfaces, June 22 – 25, Cavtat, Croatia: **used three sets of heuristics.**

KEY CONCEPTS

Given the self-evident diversity of current and emerging technologies, our aim is to explore the extent to which different technologies require different (but perhaps overlapping) sets of heuristic standards. To investigate this working hypothesis, we are working on two angles. Investigate:

1. the ways in which users understand, treat and classify different technologies
2. how different technologies generate different heuristic standards.

Study One

Methods

The first question was considered by Adams, Smith-Atakan and Granić (2009). We developed two expectations about the cognitive models of computer literate users (see figures). First, one expectation was that computer literate users would simply view all technological variants as members of the generic group "technologies" with no sub-groups at all. Second, we expected, perhaps more strongly, that technologies would fall into distinct categories as reflected in the research literature, such as "mobile", "traditional". "ambient" etc. A sample of sixteen PhD students in computing science were asked to inspect a list of different types of technology and to classify them into groups by similarity as they thought fit. They could use as many or as few categories and members per category as they wished. They were chosen as they were likely to be up to date and aware of current technologies.

Technologies used:

1. Software applications / PCs
2. Web sites
3. Wearable systems
4. Personal e.g. a personal diary
5. Group / team based technology e.g. collaborative, group project management system
6. Information management systems
7. Command and control systems
8. A mobile system e.g. a navigational system
9. An anthropomorphic system
10. Self-reflective systems
11. Dialog systems
12. Mobile phone based functions
13. Life critical systems
14. Entertainment systems
15. Creative systems e.g. creating art
16. Large scale displays
17. Information kiosks
18. Virtual reality systems

Expected results

To illustrate what data we would expect for a list of eight hypothetical items, if (a) they formed a homogenous group or (b) they fell into distinct groups with distinct memberships, consider the following two tables. Note that each association is included twice. This convention is adopted to enable the identification of each association with each item. For example, in table two (below), item one has three associations and item two has three associations, but they share one association (1 / 2). This convention treats individual and overall totals equally and does not introduce bias.

(a) a completely homogenous group would look like this (i.e. 56 significant associations for eight items). All possible associations are significant, though not necessarily at the same level;

TABLE ONE: Hypothesis one: significant associations between all items

Significant chi square values indicating significant associations							
56 significant associations (7 x 8) out of a possible total of 56 associations { i.e. n(n-1) = 8 x 7 = 56}							
1st	**2nd**	**3rd**	**4th**	**5th**	**6th**	**7th**	
1 and 2	1 and 3	1 and 4	1 and 5	1 and 6	1 and 7	1 and 8	**7 associations**
2 and 1	2 and 3	2 and 4	2 and 5	2 and 6	2 and 7	2 and 8	**7 associations**
3 and 1	3 and 2	3 and 4	3 and 5	3 and 6	3 and 7	3 and 8	**7 associations**
4 and 1	4 and 2	4 and 3	4 and 5	4 and 6	4 and 7	4 and 8	**7 associations**
5 and 1	5 and 2	5 and 3	5 and 4	5 and 6	5 and 7	5 and 8	**7 associations**
6 and 1	6 and 2	6 and 3	6 and 4	6 and 5	6 and 7	6 and 8	**7 associations**
7 and 1	7 and 2	7 and 3	7 and 4	7 and 5	7 and 6	7 and 8	**7 associations**
8 and 1	8 and 2	8 and 3	8 and 4	8 and 5	8 and 6	8 and 7	**7 associations**
8 assocns	**8 assocns**	**8 assocns**	**8 assocns**	**8 assocns**	**8 assocns**	**8 assocns**	**56 associations**

(b) two groups of four different items in each would look like this. Only those associations within a group are significant, between group associations are not.

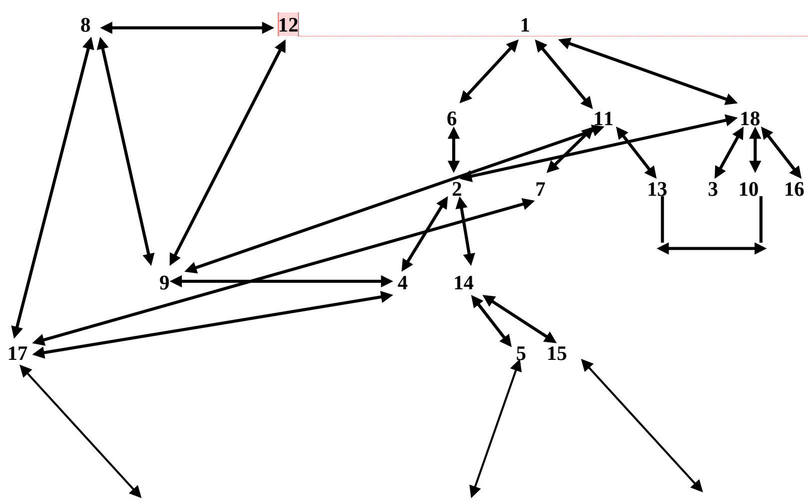
TABLE TWO: Hypothesis two: significant associations that indicates distinct groups

Significant chi square values (p<.05) significant associations						
24 significant associations (4 x 6) out of a possible total of 56 associations						
1	**2**	**3**	**4**	**5**	**6**	
1 and 2	1 and 3	1 and 4				3 associations
2 and 1	2 and 3	2 and 4				3 associations
3 and 1	3 and 2	3 and 4				3 associations
4 and 1	4 and 2	4 and 3				3 associations
			5 and 6	5 and 7	5 and 8	3 associations
			6 and 5	6 and 7	6 and 8	3 associations
			7 and 5	7 and 6	7 and 8	3 associations
			8 and 5	8 and 6	8 and 7	3 associations
4 assocns	**4 assocns**	**4 assocns**	**4 assocns**	**4 assocns**	**4 assocns**	**24 associations**

Results

The results based on measuring the degree of association between technologies ($p<0.05$) showed that neither of the above views could be supported. The different technologies are best portrayed as members of an associationistic network, in which the similarity between different technologies is represented by their distance in the network. All items were included in at least one association. Most items are included in only a few associations which combine to produce a network of associations, a result is remarkably consistent with well established theories of human semantic memory. This important result takes this research in a new direction.

FIGURE ONE: Significant associations between items ($p < 0.05$) :



Comment [MU1]:

17 = Virtual reality systems Heuristics:	5 = Group / team technology Heuristics	15 = Creative systems Heuristics
(1) Immersion (2) Suitability of reality (3) Stability (4) Security etc	(1) Simultaneity (2) Display quality (3) Captures team structure (4) Captures task structure	(1) Creative resources (2) Suitable ambience (3) Stimulating (4) recording quality

Study Two

Methods and Results

This study replicated the findings of study one and sought to explore how heuristic accessibility standards could be applied to different technological variants, even when seen as part of a semantic network. The method used was to ask forty participants (IT undergraduates) to designate a small number of accessibility criteria to each technology variant. The results demonstrate that these, admittedly computer literate, users were very comfortable in assigning different criteria to different technologies. Current work is exploring the extent that different technologies share heuristic standards as a function of the perceived similarity of the technologies.

Conclusions

This work has set out to explore the question of different accessibility, heuristic standards for different technologies and how to develop such standards in the face of technological diversity. The conclusion is that technologies cannot be seen as only members of a single category (as we expected) but also do not fall into sub-groups (contrary to our expectations). Instead, technological variants are seen by our samples of computer literate users seen these variants as forming semantic networks, the more dissimilar they are, the further away they are in the network. a result is remarkably consistent with well established theories of human semantic memory (Collins and Loftus, 1975; Collins and Quillian, 1969). This is an important result for five reasons, First, it demonstrates how we can represent user knowledge of emerging technological platforms. Second, it reveals that this representation is more complex than might have been envisioned on purely simple practical grounds. Third, it makes a link between (a) practical concerns about the implications of how we envisage technologies and (b) substantial cognitive science theories of semantic memory. Fourth, it takes this research in a new direction. Fifth, we have been able to use this semantic network approach to technological variants to generate a new generation of heuristic accessibility standards.

References

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